Evaluating the Usability, Perceived Performance, and Perceived Effects of KBGAN iHealth© and KBGAN iFeed© Mobile Apps for Buffalo Management in Selected Municipalities in the Philippines

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Abstract: This study evaluates the KBGAN iHealth© and KBGAN iFeed© mobile apps designed for buffalo health and feeding management, particularly for agricultural extension professionals (AEPs) in selected Philippine municipalities. These apps aim to address challenges in buffalo management, such as limited access to veterinary expertise, personalized recommendations, organized data, communication channels, and difficulties in calculating ideal feed compositions and meeting the distinct needs of smallholder farmers and AEPs. Despite System Usability Scale (SUS) scores indicating marginal acceptability for both apps, weighted mean scores by AEPs for statements assessed on a 5-point Likert scale (1 as strongly disagree and 5 as strongly agree), demonstrate that AEPs reported high confidence in the accuracy of buffalo health diagnostics (Mean of 4.20) and health management recommendations (Mean of 4.17) provided by KBGAN iHealth©. Similarly, KBGAN iFeed© received favorable ratings, with AEPs expressing agreement on the accuracy of feeding recommendations (Mean of 3.89) and the facilitation of feeding ration computations (Mean of 4.00). These positive perceived performance outcomes, coupled with increased confidence (Mean of 4.03) and motivation (Mean of 4.00) among AEPs, suggest the potential for frequent and consistent app usage despite usability concerns. Chi-square tests examining the relationship between AEP characteristics and SUS scores for the apps reveal significant associations between AEPs' education and experience levels and SUS scores for KBGAN iFeed©. The choice of IT device also influences KBGAN iHealth© SUS scores. Proposed enhancements by AEPs include refining algorithms, improving the user interface for navigation, speed, and efficiency, and incorporating features such as photo uploads and geotagging.

Keywords: Mobile apps, usability, perceived performance, agricultural extension professionals.

INTRODUCTION

Water buffalo management in the Philippines poses numerous challenges for smallholder farmers and agricultural extension professionals (AEPs). Challenges include limited access to veterinary expertise, timely diagnosis, personalized recommendations, and organized data. Additionally, farmers and AEPs face difficulties in identifying health issues, calculating ideal feed compositions, and accessing accurate information on feed ingredients and prices. Communication channels for sharing interventions and updates are also limited. In response to these intricate challenges, mobile devices such as smartphones and tablets equipped with applications (or apps) emerge as an indispensable extension medium for technology transfer [1] and information dissemination to enhance the quality of decision-making [2]. A mobile app that runs on a device's operating system and can operate offline or does not require internet access can be a valuable tool for AEPs, as it provides flexibility for greater reach regardless of location or time, as well as superior data acquisition and storage capacity. The AEPs provide extension and advisory services (EAS) to their clients, frequently in remote and geographically isolated areas with limited access to conventional information sources, such as extension publications and computers. Moreover, a mobile app enables AEPs to rapidly disseminate information [3], which could be especially useful in addressing animal health concerns among livestock farmers, for instance. Animal health diagnosis capabilities can be incorporated into mobile apps, facilitating prompt and efficient management and incorporating proper documentation of animal diseases.

The Knowledge Brokerage, Guidance, and Advisory Network (KBGAN) iHealth© mobile app is an example of such a diagnostic tool developed under the

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Extension and Advisory Services Information System (EASIS) Project between the Philippine Carabao Center (PCC) and the Grameen Foundation (GF) to help AEPs such as field technicians and veterinarians respond promptly to buffalo health concerns. The PCC operates under the Department of Agriculture (DA) and is responsible for conserving, propagating, and promoting the carabao (water buffalo) as a source of draft animal power, meat, milk, and hide. It offers technical and EAS to smallholder buffalo farmers in its coverage areas in accordance with its mandate. The GF, a non-profit organization in the Americas, Africa, and Asia, utilizes digital technology and data to empower impoverished and marginalized individuals, particularly women, and the agencies and actors supporting them to eradicate poverty and hunger. The PCC and the GF have formalized their partnership in pursuit of their shared goals to improve the lives of smallholder farmers in underserved communities.

The KBGAN iHealth© mobile app, developed through the PCC-GF collaboration, assesses buffalo health conditions, recommends actions, and records farmer and buffalo data for historical analysis. It enables easy information sharing via a short messaging service, features a warning system to protect pregnant dairy buffaloes, and synchronizes online and offline data. A powerful tool for AEPs, it ensures effective and timely animal health services. The KBGAN iFeed© mobile app, part of the EASIS Project, aids AEPs and technicians in calculating cost-effective feed rations for optimal buffalo nutrition. The testing phase targets local government unit (LGU) technicians, AEPs, and farmer clients, requiring evaluation to ensure a positive user experience [4] and successful adoption of recommended interventions.

In this study, it was hypothesized that AEPs' perceptions of the KBGAN iHealth© and KBGAN iFeed© mobile app's usability and utility will positively affect their intent to use it for delivering EAS. By examining the Technology Acceptance Model (TAM) constructs of Perceived Ease of Use (PEU) and Perceived Usefulness (PU), as developed by [5, 6], in the contexts of the mobile apps' usability and perceived performance, this study aimed to shed light on the factors that influence the acceptance and adoption of the apps among AEPs. Such insights can contribute to improving extension service delivery, ultimately benefiting agricultural stakeholders and promoting environmentally sustainable agricultural practices.

While prior research on mobile-based agricultural EAS has often focused on message quality [7] and socio-cultural dynamics [8], it has tended to neglect the usability and perceived performance of mobile apps for AEPs. This evaluation addresses this gap by considering app usability and its impact on AEPs' confidence and motivation, providing valuable insights into the significance of mobile app usability in enhancing extension services.

The study aimed to evaluate the KBGAN iHealth© and KBGAN iFeed© mobile apps developed under the EASIS project as a modality for delivering EAS to dairy buffalo farmers. Specifically, it aimed to (1) measure the usability rating and perceived performance of KBGAN iHealth© and KBGAN iFeed© mobile apps by the AEPs; (2) measure the perceived effects of using the KBGAN iHealth© and KBGAN iFeed© mobile apps on the confidence and motivation of the AEPs; (3) identify variables or factors that relate with usability of the KBGAN iHealth© and KBGAN iFeed© mobile apps; and (4) recommend ways to enhance the usability and functionality of KBGAN iHealth© and KBGAN iFeed© mobile apps.

MATERIALS AND METHODS

Conceptual Framework

Technology Acceptance Model

The current study is anchored on the TAM [5, 6], which seeks to uncover the factors influencing technology acceptance and rejection. TAM provides a framework for explaining and predicting the determinants behind these outcomes, allowing for the implementation of appropriate interventions. Fundamental constructs of TAM include "Perceived Usefulness" (PU), or the belief that using a system or a technology enhances job performance, and "Perceived Ease of Use" (PEU), or the belief that using a system or a technology requires minimal effort [5]. Applications seen as more user-friendly and easier to operate are more likely to be accepted by users. In other words, users are more likely to adopt technology and perceive it as advantageous when they recognize its facilitation of task completion [9].

Perceived Performance and Usability

In this study, we adopt the term “Perceived Performance”, a concept that provides a nuanced interpretation of TAM's PU. It entails an individual's anticipations regarding the technology's functioning within the context of their workplace [10]. This concept aligns seamlessly with the TAM framework, as it further

delves into the user's perspective, probing their expectations of how a technology will perform in their specific work environment. In essence, “Perceived Performance” is an extension of PU, emphasizing the contextual relevance of technology in enhancing job performance. Users' perceptions of a technology's perceived performance influence their overall attitude toward the technology, which, in turn, impacts their willingness to accept or reject it.

Furthermore, we adopt the term “Usability”, which closely correlates with PEU, another fundamental construct of TAM. PEU revolves around the user's belief that employing a system or technology requires minimal effort. In parallel, "Usability" assesses how efficiently and effectively users can interact with a system, product, or service within a specific context. Both "Usability" and PEU strongly emphasize the user experience, examining whether users perceive technology as requiring minimal effort to achieve their goals. When a system is deemed highly usable, it echoes a high level of PEU within the TAM framework. In essence, users find the technology easy to navigate and operate, aligning with their belief that it entails minimal effort. This alignment between "Usability" and PEU is pivotal in technology acceptance. When users perceive a technology as both usable and user-friendly, they are more likely to accept and adopt it, as it aligns with their expectations of ease, efficiency, and effectiveness.

Usability in Human-Computer Interaction (HCI)

In the context of usability and its significance, technology acceptance is closely linked to user beliefs, while usability pertains to technology's actual or practical application [11]. Among software engineering domains, usability stands closest to the user, constituting a pivotal phase for end users. It embodies the degree to which designated users can effectively, efficiently, and satisfyingly accomplish predefined goals when engaging with a system, product, or service within a specific usage context [12].

A critical aspect within the domain of HCI is usability testing, aimed at evaluating the ease of use of a specific system. It revolves around the idea that users should be able to grasp how to navigate a website or application swiftly; otherwise, their engagement might be short-lived. The most effective approach to assess the usability of software, applications, or systems involves garnering input from either experts or actual users [13].

In the context of mobile applications, which usually have a lot of content on small screens, usability testing must be more user-centric. The end user should be included in the usability testing at an early stage so that satisfaction, efficiency, and effectiveness can be perfected before major extended functionality is implemented, at which point a new usability evaluation with the end customer should be conducted [14].

Expanding the Scope of TAM

TAM is a well-known theoretical framework that examines the propensity of users to adopt technological advances [15]. It explains the adoption of technological products and services, with beliefs about PU and PEU influencing people's attitudes and use of new technology [5]. These beliefs influence usage intentions, adoption, and subsequent behavior significantly. However, there is a need for additional research into how users perceive the usefulness of technology and the factors that influence its acceptance in different environments.

TAM is also founded on the theory of reasoned action [16], which posits that an individual's social behavior is influenced by their attitude and predicts their use of information systems. Even though TAM elements have been extensively tested or applied [6, 17-21], research on user perceptions of technology usefulness is still required. Previous studies have not adequately considered other external variables or factors such as age, education, and training, among others, that could influence technology acceptance and willingness to use, which the present study attempts to address.

Guided by the TAM [5], the current study adopts the conceptual framework as presented in Figure **1**, which suggests that the “Usability” (which corresponds to PEU) and “Perceived Performance” (aligns with PU) of a technology (KBGAN mobile apps) were believed to have a perceived effect on the user's attitude. This effect is reflected in their confidence and motivation, ultimately influencing their decision to use or reject the technology. Taking its contextualized definition from a related study on communicative competence [22], *perceived effect* in this study is defined as a subjective assessment made by the AEPs regarding the influence and outcomes of using the KBGAN iHealth© and KBGAN iFeed© mobile apps on their confidence and motivation levels when providing agricultural guidance and support.

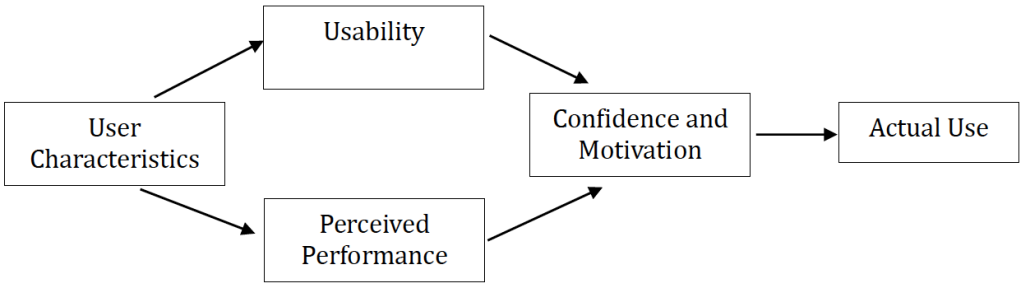

Figure 1: Conceptual Framework of the Study; adapted from [5].

Research Design

The study, conducted from June 2022 to August 2023, employed a descriptive research design encompassing observation, note-taking, in-depth narration, data collection, and statistical analysis.

The PCC established specific criteria for the selection of study sites, including the presence of a carabao-based enterprise development (CBED) project, the availability of at least 28 farmers per site, and at least 20% of the crossbred buffaloes (a product of crossing native carabaos with purebred, Murrah-based, dairy buffaloes) in each site are lactating. Under the said project, the PCC provides crossbred female buffaloes to qualified farmers who are members of conduit cooperatives, infrastructure support to the cooperatives in the form of a mini dairy processing facility and products outlet, as well as training, marketing, and other EAS. The PCC Regional Coordinators selected farmers and AEPs to be included in the study based on recommendations from their LGU partners. Likewise, only AEPs who had received training on the KBGAN iHealth© and KBGAN iFeed© mobile apps were permitted to participate in the study.

The research team developed a program sheet in MS Excel to clean, organize, and summarize the survey, interviews, and desk reviews. The results were triangulated among and between various sources (e.g., PCC regional centers, farmer-cooperatives, and LGUs engaged in CBED project sites). The research team validated the surveys and data logs of the apps by cross-checking the interviews' recordings and validating secondary data.

Sources of Data

The PCC identified and supplied the list of participating AEPs, while the LGUs served as the study's data source. The study included CBED project sites in seven municipalities and a city spanning seven provinces in the Philippines: Nueva Ecija, Bataan, Pangasinan, Pampanga, Isabela, Iloilo, and South Cotabato. Interviews were conducted with 36 AEPs between January and August 2023 using survey questionnaires. The municipality of Bongabon and the city of Palayan in Nueva Ecija accounted for 10 AEPs, Orani and Dinalupihan in Bataan for four, San Agustin in Isabela for three, Bacolor in Pampanga for three, Asingan in Pangasinan for two, Calinog in Iloilo for nine, and Surallah in South Cotabato for five. The primary criterion for selecting respondents was the ability to use the KBGAN iHealth© and KBGAN iFeed© mobile apps during the EASIS project's implementation by AEPs.

Secondary data were gathered from their field notes, project reports, and KBGAN server data logs. This was used to evaluate the technology's utility in the field or a real-world setting.

Data Collection

To evaluate the usability of the KBGAN iHealth© and KBGAN iFeed© mobile and web apps, a subset of AEPs used the apps with buffalo farmers over four periods. Period 1 spanned March and May 2022, Period 2 spanned July and August 2022, Period 3 spanned September and October 2022, and Period 4 spanned November and December 2022. The frequency of field visits was at least one per period for periods 1 and 3 but only one per period for period 2. The surveys were administered to AEPs and buffalo farmers using purposive sampling.

This study employed quantitative and qualitative data collection techniques, including survey questionnaires and Key Informant Interview (KII) guides. For primary data collection, an on-site survey via KoBoCollect was utilized. The research team designed the survey instruments, which were translated thoroughly. Buffalo farmers in Nueva Ecija were subjected to a pre-test of the instruments used to

collect data before the actual data collection. The research team conducted KIIs with key informants identified beforehand. Included in this group were the PCC, Provincial/LGU veterinarians, veterinary assistants, and Artificial Insemination (AI) technicians. Interviews with AEPs were conducted from January to August of 2023.

The study emphasized a participatory approach in which respondents were informed of the purpose and methodology of the research and had the option to decline participation. Throughout the entirety of the research process, ethical considerations and safety procedures were observed. Specifically, the research team, composed of its local researchers and enumerators, disclosed the steps taken to ensure all farmer-respondents' appropriate, safe, and non-discriminatory participation. The team also elaborated on the strict observance and guarantee of respondent confidentiality and anonymity.

Data security was maintained throughout the research project. The findings and report were discussed with the research team. The researchers obtained farmer-respondents' signed Informed Consent forms before collecting primary data. The research team could only access data stored in a multi-level encrypted cloud drive. After evaluation, data were discarded.

Analysis of Data

The research used qualitative and quantitative methods to find the variable relationships. Data were coded, summarized, and analyzed using IBM SPSS 2009 version and MS Excel software programs.

Descriptive ratings and quantitative values were assigned to statements assessing the perceived level of performance and the perceived effect on the confidence and motivation of AEPs by the KBGAN iHealth© and KBGAN iFeed© mobile apps. This was done using a 5-point Likert scale, ranging from 1 to 5 (also called Likert weightings or weights), where 5 corresponds to the highest rating ("Strongly Agree") and 1 to the lowest rating ("Strongly Disagree") (Table **1a**). To establish the range for this Likert-type scale, we calculated the difference between the smallest value (1) and the largest value (5), resulting in a range of 4. This range was then divided by the total number of points on the scale, which is five, yielding 0.80. Subsequently, this calculated range was added to the minimum value (1) to determine the maximum value on the scale. The cell lengths were then defined in Table **1b**. Weighted means were then calculated for the said Likert scales to determine the tendency of the composite scores.

Table 1a: 5-Point Likert Scale and Descriptive Rating

Likert Scale	Descriptive Rating
5	Strongly Agree
4	Agree
3	Neutral
2	Disagree
1	Strongly Disagree

Table 1b: Ranges of 5-Point Likert Scale and Descriptive Rating

Likert Scale Range	Descriptive Rating
4.20-5.00	Strongly Agree
3.40-4.19	Agree
2.60-3.39	Neutral
1.80-2.59	Disagree
1.00-1.79	Strongly Disagree

To calculate the weighted Mean on a 5-point Likert scale, first, weights were assigned to each response category (statement about the app), typically using the above Likert scale's numeric values of 1 to 5. Each respondent's score was multiplied by the assigned weight, and these weighted scores were summed up. Simultaneously, the sum of the weights assigned to each response was calculated. Finally, the total weighted scores were divided by the total of the weights. This process gave a weighted mean that considered the importance given to each response category, offering a nuanced average on the Likert scale.

In addition, the System Usability Scale or SUS [23] was utilized to determine the mobile apps' usability level. It consists of alternating five positive and five negative statements (Table **2**). Each statement was then rated using the same 5-point scale presented in Table **1a**.

The SUS aggregate score is computed using the SUS calculation formula, with score contributions ranging from 0 to 4 for each statement. The score contribution for a positive SUS statement is the scale

Table 2: System Usability Scale (SUS) Statements were used for both the KBGAN iHealth© and KBGAN iFeed© Mobile Apps (Adapted from [23])

Statement
1. I think that I would like to use the mobile app frequently.
2. I found the mobile app unnecessarily complex.
3. I thought the mobile app was easy to use.
4. I think that I would need the support of a technical person to be able to use the mobile app.
5. I found the various functions in the mobile app were well integrated.
6. I thought there was too much inconsistency in the mobile app.
7. I would imagine that most people would learn to use the mobile app very quickly.
8. I found the mobile app very cumbersome to use.
9. I felt very confident using the mobile app.
10. I needed to learn a lot of things before I could get going with the mobile app.

position minus one, while it is five minus the scale position for a negative SUS statement. To determine the total value of the SUS statements, the sum of their scores is multiplied by 2.5. The final score ranges from 0 to 100. It is essential to note that SUS scores are not percentiles. According to [23], a SUS score above 68 is above average, while a SUS score below 68 is below average. According to the acceptability range indicator, SUS scores below 50 are considered unacceptable. In contrast, scores between 50 and 70 are marginally acceptable, 64 and 70 are marginally high, and scores between 50 and 63 are marginally low. Scores above 70 on the SUS are considered satisfactory [24]. Table **3** shows the SUS utilized in the study, as adapted from [25].

The applicability of SUS across various technologies has been demonstrated in previous studies [26, 27], including those unavailable during its initial development. The SUS statements universally apply to any technology and do not have individual significance. The statements aim to elicit strong positive and negative responses to evaluate perceived usability.

The team employed descriptive statistics, including weighted Mean, frequency count, and percentage, alongside the Chi-square test of independence, to explore potential relationships between the characteristics of AEPs (or user factors) and their SUS grades for the KBGAN iHealth© and KBGAN iFeed© mobile apps.

RESULTS

Socio-Demographic or User Factors

Table **4** provides an overview of the socio-demographic characteristics and user factors of Agricultural Extension Professionals (AEPs) participating in the study.

The average age of the AEPs was found to be 36.67 years, and a majority fell within the age range of 20 to 49. A smaller segment belonged to the 50 to 69 age group. Job tenure distribution indicated that 64% held permanent positions, while 36% were temporary. Educational attainment varied, with 61% holding

Table 3: System Usability Scale (Adapted from [25])

SUS Score	Percentile Range	Grade	Adjective	Acceptability	Net Promoter Score
0-25	0-1.9	F	Worst Imaginable	Not Acceptable	Detractor
25.1-51.6	2-14	F	Poor	Not Acceptable	Detractor
51.7-62.6	15-34	D	OK	Marginal	Detractor
62.7-64.9	35-40	C-	OK	Marginal	Passive
65-71	41-59	C	OK	Marginal	Passive
71.1-72.5	60-64	C+	Good	Acceptable	Passive
72.6-74	65-69	B-	Good	Acceptable	Passive
74.1-77.1	70-79	B	Good	Acceptable	Passive
77.2-78.8	80-84	B+	Good	Acceptable	Passive
78.9-80.7	85-89	A-	Good	Acceptable	Promoter
80.8-84	90-95	A	Excellent	Acceptable	Promoter
84.1-100	96-100	A+	Best Imaginable	Acceptable	Promoter

college degrees and 19% possessing Doctor of Veterinary Medicine degrees.

Table 4: Frequency Distribution by Categories of Socio-Demographic or user Factors (n=36)

User Factors	Frequency	Percentage
Age (years)		
20-29	12	33.33
30-39	7	19.44
40-49	12	33.33
50-59	3	8.33
60-69	2	5.56
Job Tenure		
Permanent	23	63.89
Temporary	13	36.11
Years in Service		
0-5	22	61.11
6-11	7	19.44
12-17	4	11.11
18-23	2	5.56
24-29	0	0.00
30-35	1	2.78
Educational Attainment		
Secondary	4	11.11
College	22	61.11
Masters	3	8.33
Doctor of Veterinary Medicine	7	19.44
Hours of relevant training		
0-117	26	72.22
118-235	3	8.33
236-353	6	16.67
590-707	1	2.78
IT Device Used		
Smartphone	5	13.89
Tablet	27	75.00
Both	4	11.11

Their training exposure covered diverse topics, including KBGAN iHealth© and KBGAN iFeed© mobile apps, Carabao Health and Nutrition, among others. A noteworthy trend emerged regarding technology preference, with 75% of the professionals expressing a preference for using tablets. In contrast, only about 14% opted for smartphones when using mobile apps.

KBGAN Mobile Apps Usage

The KBGAN iHealth© and KBGAN iFeed© apps demonstrated their pivotal role in recording and monitoring buffalo health and nutrition throughout the EASIS project, leveraging the logs feature. Table **5a** outlines the substantial engagement, with the KBGAN iHealth© mobile app registering 462 synchronized logs and the KBGAN iFeed© mobile app accounting for 392 during the project's duration. The frequency distribution of these logs, as presented in Table **5b**, adds granularity for a more detailed analysis of usage patterns.

Table 5a: Number of KBGAN Apps Logs Created.

EASIS Project Period	Frequency	
	KBGAN iHealth©	KBGAN iFeed©
1 (Mar-May 2022)	12	8
2 (Jul-Aug 2022)	163	90
3 (Sep-Oct 2022)	80	84
4 (Nov-Dec 2022)	207	210
SUM	462	392
MEAN	115.50	98.00

Table 5b: Categories and Frequency Distribution of Logs Created

Categories of Logs	Frequency	Percentage
No. of KBGAN iHealth© Logs		
0-9	22	61.11
10-19	4	11.11
20-29	2	5.56
30-39	6	16.67
40-49	1	2.78
50-59	1	2.78
No. of KBGAN iFeed© Logs		
0-18	29	80.56
19-37	4	11.11
57-75	2	5.56
95-113	1	2.78

Usability Rating and Perceived Performance

SUS Scores and Grades for the Mobile Apps

Tables **6a** and **6b** present the SUS scores and usability ratings by AEPs for the KBGAN iHealth© and KBGAN iFeed© mobile apps.

The mean SUS scores for KBGAN iHealth© and KBGAN iFeed© were recorded as 62.290 and 51.875, respectively. Both apps received usability grades of D, signifying an okay level of performance with marginal acceptability and room for improvement [27]. As scores below 68 are considered below average [23], the results suggest potential interface issues that merit further evaluation and enhancement.

Table 6a: SUS Grade Categories and Frequency Distribution for the KBGAN Mobile Apps

Mobile App	SUS Grade	Frequency	Percentage
KBGAN iHealth©	A	2	6
	B	4	11
	C	6	17
	D	19	53
	F	5	14
KBGAN iFeed©	A	2	6
	B	1	3
	D	19	53
	F	14	39

Table 6b: Usability Rating of the KBGAN Mobile Apps

Mobile App	Mean Score	SD	Percentile Range	Grade	Descriptive Equivalence	Acceptability
KBGAN iHealth©	62.290	10.16	15-34	D	OK	Marginal
KBGAN iFeed©	51.875	14.20	15-34	D	OK	Marginal

Perceived Performance of Mobile Apps

The Likert scale-based survey results for KBGAN iHealth© and KBGAN iFeed© mobile applications unveil a highly positive reception among AEPs (Table **7**).

KBGAN iHealth© garnered a weighted mean of 4.20, indicating strong agreement on its accuracy in determining buffalo health conditions. Additionally, AEPs expressed an overall agreement (weighted Mean of 4.17) regarding the correctness of health management recommendations provided by the app. For KBGAN iFeed©, AEPs showed agreement (weighted Mean of 3.89) regarding the accuracy of feeding recommendations for specific buffalo categories. Positive feedback on the app's facilitation of AEPs in computing or formulating feeding rations is reflected in a weighted mean of 4.00.

Perceived Effects

The Likert scale-based survey outcomes offer insights into the perceived effects of KBGAN iHealth© and KBGAN iFeed© mobile apps on AEPs (Table **8**).

Table 7: Perceived Performance of KBGAN iHealth© and KBGAN iFeed© Mobile Apps

Statements	No. of Responses per Likert Scale/Weighting*					Weighted Mean*	Descriptive Rating*
	1	2	3	4	5		
The KBGAN iHealth© app is accurate in determining the health condition of the buffaloes visited.	-	-	6	17	13	4.20	Strongly Agree
The KBGAN iHealth© app gives the correct health management recommendations for the identified health condition.	-	-	6	18	12	4.17	Agree
The KBGAN iFeed© app gives the correct feeding recommendations for a specific buffalo category.	-	1	10	17	8	3.89	Agree
The KBGAN iFeed© app helped the AEPs to easily compute or formulate a feeding ration for a specific buffalo category.	-	3	6	15	12	4.00	Agree

*Mean Range	Descriptive Rating.
4.20-5.00	Strongly Agree.
3.40-4.19	Agree.
2.60-3.39	Neutral.
1.80-2.59	Disagree.
1.00-1.79	Strongly disagree.

Table 8: Perceived Effects on Confidence and Motivation of Agricultural Extension Professionals (AEPs) using the KBGAN iHealth© and KBGAN iFeed© Mobile Apps

Statements	No. of Responses per Likert Scale/Weighting*					Weighted Mean*	Descriptive Rating*
	1	2	3	4	5		
Effects on Confidence							
The KBGAN iHealth© app made the AEPs more confident in diagnosing the health condition.	-	-	9	16	11	4.06	Agree
The KBGAN iHealth© app made the AEPs more confident in giving health management advice.	-	-	4	18	14	4.28	Strongly Agree
The KBGAN iFeed© app made the AEPs more confident in computing or formulating a feeding ration.	-	3	9	13	11	3.89	Agree
The KBGAN iFeed© app made the AEPs more confident in giving nutrition management advice.	-	1	8	17	10	4.00	Agree
The KBGAN iHealth© and KBGAN iFeed© apps made the AEPs more confident at work.	-	-	10	15	11	4.03	Agree
Effect on Motivation							
The KBGAN iHealth© and KBGAN iFeed© apps motivated the AEPs to provide better extension service.	-	-	8	20	8	4.00	Agree

*Mean Range	Descriptive Rating.
4.20-5.00	Strongly Agree.
3.40-4.19	Agree.
2.60-3.39	Neutral.
1.80-2.59	Disagree.
1.00-1.79	Strongly disagree.

The results reveal a consistently positive influence on both confidence and motivation.

AEPs expressed confidence in diagnosing buffalo health conditions (weighted Mean of 4.06) and providing health management advice (weighted Mean of 4.28) using KBGAN iHealth©. Simultaneously, KBGAN iFeed© positively influenced AEPs' confidence in computing feeding rations (weighted Mean of 3.89) and providing nutrition management advice (weighted Mean of 4.00). The combined use of both apps elevated AEPs' overall confidence at work, reflected in a weighted mean of 4.03. Additionally, both KBGAN iHealth© and KBGAN iFeed© were acknowledged as motivational factors, inspiring AEPs to enhance their delivery of extension services, evident in a weighted mean of 4.00.

User Factors versus Usability of the Mobile Apps

Table **9** presents the results of a Chi-square test exploring the relationship between user factors and SUS grades for the KBGAN mobile apps among AEPs.

The findings reveal that neither age nor job tenure substantially influences SUS grades for either app, indicating that these variables have little impact on AEPs' perceptions of the usability of KBGAN iHealth©

Table 9: Relationship between user Factors and SUS Grades among AEPs for KBGAN Mobile Apps

User Factors	Chi-square p-values	
	KBGAN iHealth© SUS grade	KBGAN iFeed© SUS grade
Age	0.4631	0.0518
Job tenure	0.3620	0.7583
Years in service	0.8657	0.0000*
Educational attainment	0.1429	0.0006*
Hours of training	0.3425	0.6554
IT Device used	0.0032*	0.2990
No. of logs	0.1879	0.3674

*Significant at 0.05 level.

and KBGAN iFeed©. However, a significant relationship exists between SUS grades, years in service, and educational attainment, specifically for KBGAN iFeed©. This suggests that as AEPs accumulate more years of service or attain higher educational qualifications, their perceptions of usability, as reflected in SUS grades, are likely to undergo substantial changes. The correlation between higher educational levels and improved critical thinking and problem-solving skills is noted, emphasizing the role of education in enhancing the ability to navigate complex interfaces effectively.

Contrarily, variables such as training hours and logs do not exhibit a significant correlation with SUS grades for either application. The study suggests that the amount of training received or the frequency of app usage, as measured by the number of logs, does not significantly influence the usability perceptions of AEPs using KBGAN iHealth© and KBGAN iFeed© apps.

The choice of IT device significantly affects KBGAN iHealth© SUS scores, in contrast to its negligible impact on KBGAN iFeed©. This underscores the pivotal role of IT device choice in shaping the perceived usability of KBGAN iHealth©, providing crucial insights for developers and stakeholders aiming to enhance the user experience for AEPs using this app.

DISCUSSION

Socio-Demographic or User Factors

The concentration of AEPs within the age range of 20 to 49 suggests a workforce with a significant representation of individuals in their prime working years. This age distribution may have implications for the familiarity and adaptability of AEPs to technological tools, considering the widespread integration of technology in various professional domains.

The job tenure distribution, with 64% holding permanent positions, indicates a stable employment landscape among the participating AEPs. This stability could influence their long-term engagement with mobile apps for agricultural extension services, impacting both usage patterns and the potential for sustained technological integration within their work routines.

Educational attainment, a critical factor influencing cognitive skills and adaptability, varies within the cohort. The majority, with college degrees, may exhibit a certain level of technological literacy and problem-solving skills. Conversely, those with Doctor of Veterinary Medicine degrees may bring specialized domain knowledge, potentially impacting their utilization and understanding of the KBGAN mobile apps. Higher educational levels often correlate with improved critical thinking and problem-solving skills [28]. Those with higher educational attainment tend to have a better grasp of complex systems and can navigate intricate interfaces more effectively. They are also more capable of understanding abstract concepts and adapting to new technologies, ultimately enhancing their ability to use systems with greater usability.

The training exposure suggests a diverse knowledge base among AEPs. The inclusion of specific health and nutrition apps aligns with the focus on buffalo health and nutrition monitoring in the study. Understanding the extent of their exposure to these topics becomes crucial in interpreting their subsequent interactions and engagement with the KBGAN mobile apps.

A majority preferring tablets over smartphones impacts user experience due to screen size, interface, and functionality differences. Developers should consider these preferences when optimizing mobile apps for agricultural extension.

KBGAN Mobile Apps Usage

The significant number of synced logs shows active AEP engagement with the mobile apps. This data is valuable for understanding buffalo health and nutrition monitoring.

Recording activities on both KBGAN iHealth© and iFeed© is crucial for monitoring AEP performance and usage patterns. Continuous monitoring helps identify areas needing more training or support, aligning with ongoing professional development principles. Keeping track of records supports an iterative improvement process, enabling AEPs to assess progress, identify opportunities for improvement, and ensure successful app implementation in their workflows.

Identifying issues through logging is crucial for addressing app-related challenges like bugs and technical issues [29]. Quick identification and resolution by developers and support teams are vital for maintaining the functionality and reliability of both iHealth and iFeed apps. This proactive approach ensures a smooth user experience, contributing to the overall success and acceptance of the mobile apps among AEPs.

Additionally, logging creates a valuable feedback loop for AEPs and supervisors. This mechanism helps identify areas needing extra support or training, fostering a collaborative learning environment within the team [29]. It serves as a platform for sharing best practices, improving overall performance, and cultivating a culture of continuous improvement in agricultural extension [30].

Extending the use of KBGAN iHealth© and iFeed© apps is also crucial for AEPs monitoring buffalo health and nutrition. Prolonged usage is essential for thorough monitoring, improved data analysis, and early detection of chronic conditions. Sustained use enhances holistic assessment and collaborative consultations with experts, highlighting the transformative potential of these apps in effective buffalo welfare management.

Usability Rating and Perceived Performance

SUS Scores and Grades for the Mobile Apps

The usability grades of D for both apps indicate an OK level of performance but highlight areas with marginal acceptability and room for improvement. This aligns with the acknowledgment that SUS scores below 68 indicate below-average performance [23]. Identifying interface issues becomes a priority, emphasizing the need for targeted development efforts to enhance the overall usability of both apps.

Drawing insights from previous studies, the consistency between SUS scores obtained shortly after system exposure and those obtained after prolonged use is noted [27]. This finding underscores the reliability of users' initial impressions, emphasizing the importance of addressing interface issues early in development. The two-factor structure of SUS, evaluating both learnability and overall usability, provides a nuanced understanding of user experiences. The correlation between usability and learnability, as established in independent validation studies [31], emphasizes the interplay between these factors in shaping user perceptions.

Analyzing the SUS scores of KBGAN iHealth© and KBGAN iFeed© offers valuable insights into app performance and user perception. The "OK" level of performance signals the need for further development, particularly in addressing potential interface issues and enhancing users' learnability. This iterative approach to development ensures that user feedback is actively incorporated, contributing to an improved overall user experience and sustained user engagement within the agricultural extension context.

Perceived Performance of Mobile Apps

AEPs strongly agree on the accuracy of buffalo health conditions and health management recommendations in KBGAN iHealth©, highlighting its effectiveness in agricultural extension services. Likewise, the positive feedback on KBGAN iFeed©, specifically its accurate feeding recommendations and assistance in formulating feeding rations, emphasizes its value in buffalo health and nutrition monitoring.

Understanding user satisfaction within the broader framework of essential quality characteristics of mobile apps, such as usability, performance, reliability, and robustness [32], becomes imperative. The seamless integration of these characteristics contributes to user-perceived quality and overall experience. AEPs' continued use of the KBGAN mobile apps is closely tied to their perception of quick, efficient, and trustworthy performance. This aligns with the acknowledged impact of user perception on engagement and retention, where unresponsiveness or unreliability can lead to frustration and eventual disuse [33, 34].

The accuracy and correctness of health assessments, feed ration formulations, and recommendations provided by KBGAN iHealth© and iFeed© directly influence perceived performance and efficacy. AEPs, relying on these apps for critical decisions in buffalo health and feeding management, emphasize the need for immediate, accurate assessments and trustworthy recommendations. The perceived performance, including speed and responsiveness, is intricately linked to the apps' ability to facilitate precise decision-making [35]. Thus, a harmonious blend of accurate algorithms, feed ration recommendations, and a user-friendly interface emphasizing speed and efficiency contributes to the positive perceived performance and efficacy of KBGAN iHealth© and iFeed© apps. This, in turn, fosters sustained user engagement and retention among AEPs.

Perceived Effects

The consistent positive influence on AEPs' confidence in diagnosing buffalo health conditions and providing management advice signifies the efficacy of KBGAN iHealth© in supporting their decision-making processes. Similarly, the positive impact of KBGAN iFeed© on confidence in computing feeding rations and providing nutrition management advice aligns with its role in facilitating accurate and informed decision-

making in the realm of buffalo health and nutrition. The combined use of both apps emerges as a catalyst for elevating AEPs' overall confidence at work. The synergistic effect of KBGAN iHealth© and KBGAN iFeed© contributes to a comprehensive skill set, empowering AEPs to navigate various facets of their roles with confidence.

Motivational factors, as acknowledged by AEPs, further amplify the transformative potential of these mobile apps. The motivation to enhance the delivery of extension services reflects a commitment to continuous improvement and the adoption of technology-driven solutions to advance agricultural extension practices.

Aligning with the Technology Acceptance Model (TAM), the reported motivation of AEPs to use KBGAN iHealth© and iFeed© apps indicates a propensity for frequent and consistent usage. This alignment reinforces the positive influence of the apps on AEPs' confidence and motivation, supporting their acceptance and integration into work routines for improved efficiency and productivity.

While acknowledging that SUS scores primarily assess usability, the lower SUS mean scores indicate areas for improvement in the app's interface. However, the positive perceived effects reported by AEPs suggest the continued value and utility of the apps, outweighing some usability concerns. Beyond usability, factors such as relevance to work, convenience, time-saving benefits, and potential for professional growth contribute to positive perceptions and motivation to use the apps.

The robust support for TAM hypotheses underscores the significance of KBGAN iHealth© and iFeed© mobile apps in positively influencing AEPs' confidence, motivation, and preference for delivering extension and advisory services. The agreement levels among AEPs affirm that the apps effectively enhance their abilities, providing valuable tools for their roles and validating the hypothesis that perceptions of usability and utility significantly impact their intent to use the apps in agricultural extension contexts.

User Factors versus Usability of the Mobile Apps

The non-significant influence of age and job tenure on SUS grades implies that these factors have minimal bearing on AEPs' perceptions of usability. This suggests a potential universality in the usability experience across different age groups and job tenures among AEPs using KBGAN mobile apps.

In contrast, the observed relationship between years in service, educational attainment, and SUS grades for KBGAN iFeed© underscores the impact of experience and education on usability perceptions. As AEPs accumulate more years of service or achieve higher educational qualifications, their enhanced critical thinking and problem-solving skills contribute to a nuanced understanding of complex interfaces, influencing their perceived usability.

The importance of educational attainment is emphasized in shaping technological literacy, enabling individuals to engage with digital technologies effectively. This aligns with the finding that higher educational levels correlate with improved usability perceptions, providing valuable insights for developers and decision-makers.

While training hours and logs do not significantly correlate with SUS grades, the substantial impact of IT device choice on KBGAN iHealth© SUS scores highlights the crucial link between device usability and design, directly influencing user interactions and perceptions. The limitations of mobile device interfaces, including small screens, low-resolution displays, unconventional input methods, poor connectivity, and complex navigation [36, 37], are acknowledged, emphasizing the need for careful consideration in designing mobile apps.

Recommendations

The study proposes technical enhancements for KBGAN iHealth© to boost usability and functionality. This includes allowing photo uploads from users' galleries to facilitate convenient buffalo inspection before recording and streamlining the data entry process.

For efficient record management, incorporating user-requested features in KBGAN iHealth© is recommended. This involves adding functionalities such as indicating dead or sold buffaloes, enabling on-the-spot farmer enrolment, integrating a dedicated button for recording artificial insemination services, and incorporating calendar integration for activities like vaccination and deworming, thereby monitoring and enhancing buffalo health.

Expanding KBGAN iHealth©'s record-keeping for buffalo pregnancies is advised. This includes adding reminders for reheat, pregnancy diagnosis, status, and calendar reminders for post-birth calf health.

Using geotagging [38] in KBGAN iHealth© is suggested to enhance transparency and supervision, with the caveat that clear standard operating procedures and promotional efforts for user adoption are essential.

Improving user data control in KBGAN iHealth© involves allowing the deletion of logs and records, introducing home sync, and incorporating a history page for easier recall. Additionally, features like farmer syncing and symptom search are suggested while sharing the training trainer's kit, conducting refresher courses for AEPs, and aligning technical knowledge with buffalo health and medicines can enhance user proficiency.

For KBGAN iFeed©, continuous training, and workshops are recommended, emphasizing the importance of ingredient selection. The user experience can be enhanced by integrating photos and local grass names for reference, enabling offline access to reference materials, and incorporating features for body condition score (BCS) and body weight estimation. To further boost the effectiveness of KBGAN iFeed©, it is advised to support users through local ingredient-based selection, provide comprehensive training resources, and offer improved gadgets.

CONCLUSIONS

Our investigation into the KBGAN iHealth© and KBGAN iFeed© mobile apps among Agricultural Extension Professionals (AEPs) underscores marginal acceptability in usability, as gauged by the System Usability Scale (SUS) and user ratings. While demographic factors such as age and job tenure showed limited influence on usability perceptions, a closer examination revealed significant associations between years in service and educational attainment with usability perceptions for KBGAN iFeed©, emphasizing the role of education in adapting to digital interfaces.

The amount of training received and the frequency of app usage did not significantly influence usability perceptions, suggesting a more nuanced understanding is required to discern user opinions. However, the positive perceptions of app performance, manifesting in heightened confidence and motivation among AEPs, indicate a potential for consistent usage, thereby offering evidence that supports our initial hypothesis. These findings align with the Technology Acceptance Model (TAM) principles, suggesting a positive influence on AEPs' work routines and potential efficiency and productivity gains.

Notably, the impact of IT device choice emerged as a critical factor, significantly affecting SUS scores for KBGAN iHealth© while having a negligible impact on KBGAN iFeed©. This highlights the importance of considering device compatibility and design in optimizing perceived usability, providing essential insights for developers and stakeholders seeking to enhance the user experience for AEPs. In essence, these findings offer a nuanced perspective on the interplay of factors influencing app usability and adoption, pointing towards targeted improvements and emphasizing the significance of user-centered design principles in advancing mobile applications in the agricultural extension domain.

AVAILABILITY OF DATA

The raw data are available upon request.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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REFERENCES

[1] Nielsen A. American families see tablets as playmate, teacher and babysitter. 2012. Available from: https://www.nielsen.com/insights/2012/american-families-see-tablets-as-playmate-teacher-and-babysitter/.

[2] Tiwari R, Phand S, Sharma M. Status and scope of information and communication technology for livestock and poultry production in India-A review. Indian Journal of Animal Sciences 2010; 80(12): 1235. Available from: https://epubs.icar.org.in/index.php/IJAnS/article/view/2235/561.

[3] Drill SL. Tools for creating mobile applications for Extension. Journal of Extension 2012; 50(6): n6. https://doi.org/10.34068/joe.50.06.27

[4] Fulcher BD, Little MA, Jones NS. Highly comparative time-series analysis: the empirical structure of time series and their methods. Journal of the Royal Society Interface 2013; 10(83): 20130048. https://doi.org/10.1098/rsif.2013.0048

[5] Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly 1989: 319-40. https://doi.org/10.2307/249008

[6] Venkatesh V, Davis FD. A theoretical extension of the technology acceptance model: Four longitudinal field studies. Management Science 2000; 46(2): 186-204. https://doi.org/10.1287/mnsc.46.2.186.11926

[7] Kassem HS, Shabana RM, Ghoneim YA, Alotaibi BM. Farmers' perception of the quality of mobile-based extension services in Egypt: A comparison between public and private provision. Information Development 2020; 36(2): 161-80. https://doi.org/10.1177/0266666919832649

[8] Mugabi N, Omona J, Jansson B. Revolutionalizing agriculture extension delivery through mobile telephony: the experience of village enterprise agent model in Greater Masaka area, Uganda. WIT Transactions on Ecology and the Environment 2018; 217: 963-74. https://doi.org/10.2495/SDP180811

[9] Dillon A, Morris MG. User acceptance of new information technology: theories and models 1996. Available from: http://hdl.handle.net/10150/105584

[10] Soronen O, Widengren H. Differences in Perceived Performance of Mobile Devices Between Managers and Employees in Grocery Stores 2019. Available from: https://urn.kb.se/resolve?urn=urn: nbn: se: umu: diva-161031.

[11] Cruz AM, Portillo HPL, Daum C, Rutledge E, King S, Liu L. Technology acceptance and usability of a mobile app to support the workflow of health care aides who provide services to older adults: pilot mixed methods study. JMIR Aging 2022; 5(2): e37521. https://doi.org/10.2196/37521

[12] ISO I. Ergonomics of human-system interaction—Part 11: Usability: Definitions and concepts (ISO 9241-11: 2018) 2018. Available from: https://www.iso.org/obp/ui/#iso: std: iso: 9241: -11: ed-2: v1: en.

[13] Nielsen J, editor Usability inspection methods. Conference companion on Human factors in computing systems; 1994. https://doi.org/10.1145/259963.260531

[14] Tan W-S, Liu D, Bishu R. Web evaluation: Heuristic evaluation vs. user testing. International Journal of Industrial Ergonomics 2009; 39(4): 621-7. https://doi.org/10.1016/j.ergon.2008.02.012

[15] Davis FD. User acceptance of information technology: system characteristics, user perceptions, and behavioral impacts. International Journal of Man-Machine Studies. 1993; 38(3): 475-87. https://doi.org/10.1006/imms.1993.1022

[16] Ajzen I, Fishbein, M. Understanding attitudes and predicting social behavior. Englewood-Cliffs, NJ: Prentice-Hall 1980.

[17] Henderson R, Divett MJ. Perceived usefulness, ease of use, and electronic supermarket use. International Journal of Human-Computer Studies 2003; 59(3): 383-95. https://doi.org/10.1016/S1071-5819(03)00079-X

[18] Lu J, Yu CS, Liu C, Yao JE. Technology acceptance model for wireless Internet. Internet Research 2003. https://doi.org/10.1108/1066224031047822

[19] Lai PC, Zainal AA. Perceived risk as an extension to TAM model: Consumers' intention to use a single platform e-payment. Australia Journal Basic and Applied Science 2015; 9(2): 323-30. Available from: https://www.ajbasweb.com/ old/ajbas/ 2015/February/323-330.pdf.

[20] Zahid MJA, Ashraf MM, Malik BT, Hoque MR, editors. Information communication technology (ICT) for disabled persons in Bangladesh: Preliminary study of impact/outcome. Grand Successes and Failures in IT Public and Private Sectors: IFIP WG 86 International Working Conference on Transfer and Diffusion of IT, TDIT 2013, Bangalore, India, June 27-29, 2013 Proceedings; 2013: Springer. https://doi.org/10.1007/978-3-642-38862-0_48

[21] Armenteros M, Liaw SS, Fernández M, Díaz RF, Sánchez RA. Surveying FIFA instructors' behavioral intention toward the Multimedia Teaching Materials. Computers & Education 2013; 61: 91-104. https://doi.org/10.1016/j.compedu.2012.09.010

[22] Putra I, Saukah A, Basthomi Y, Irawati E. The acceptance of the English language learning mobile application Hello English across genders and experience differences. International Journal of Emerging Technologies in Learning (IJET) 2020; 15(15): 219-28. https://doi.org/10.3991/ijet.v15i15.11077

[23] Brooke J. SUS-A quick and dirty usability scale. Usability evaluation in Industry 1996; 189(194): 4-7. Available from: https://www.researchgate.net/profile/John-Brooke6/publication/228593520_SUS_A_quick_and_dirty_usability_scale/links/5f24381392851cd302cbaf25/SUS-A-quick-and-dirty-usability-scale.pdf.

[24] Ng AWY, Lo HWC, Chan AHS, editors. Measuring the Usability of Safety Signs: A use of system usability scale (SUS). Proceedings of the International MultiConference of Engineers and Computer Scientists; 2011: Citeseer.

[25] Sauro J. 5 Ways to Interpret a SUS Score 2018. Available from: https://measuringu.com/interpret-sus-score/

[26] Bangor A, Kortum P, Miller J. Determining what individual SUS scores mean: Adding an adjective rating scale. Journal of Usability Studies 2009; 4(3): 114-23. Available from: https://uxpajournal.org/determining-what-individual-sus-scores-mean-adding-an-adjective-rating-scale/.

[27] Sauro J. Measuring usability with the system usability scale (SUS) 2011. Available from: https://measuringu.com/sus/

[28] Snyder LG, Snyder MJ. Teaching critical thinking and problem-solving skills. The Journal of Research in Business Education 2008; 50(2): 90. Available from: https://dme.childrenshospital.org/wp-content/uploads/2019/02/Optional-_Teaching-Critical-Thinking-and-Problem-Solving-Skills.pdf.

[29] Kirwan M, Duncan MJ, Vandelanotte C, Mummery WK. Design, development, and formative evaluation of a smartphone application for recording and monitoring physical activity levels: the 10,000 Steps "iStepLog". Health Education & Behavior 2013; 40(2): 140-51. https://doi.org/10.1177/1090198112449460

[30] O'dell C, Grayson CJ. If only we knew what we know: Identification and transfer of internal best practices. California Management Review 1998; 40(3): 154-74. https://doi.org/10.2307/41165948

[31] Borsci S, Federici S, Lauriola M. On the dimensionality of the System Usability Scale: a test of alternative measurement models. Cognitive Processing 2009; 10: 193-7. https://doi.org/10.1007/s10339-009-0268-9

[32] Nitze A, Schmietendorf A, editors. A survey on mobile users' software quality perceptions and expectations 2015 IEEE Eighth International Conference on Software Testing, Verification and Validation Workshops (ICSTW) 2015; IEEE. https://doi.org/10.1109/ICSTW.2015.7107417

[33] Huang G, Ren Y. Linking technological functions of fitness mobile apps with continuance usage among Chinese users: Moderating role of exercise self-efficacy. Computers in Human Behavior 2020; 103: 151-60. https://doi.org/10.1016/j.chb.2019.09.013

[34] Kim YH, Kim DJ, Wachter K. A study of mobile user engagement (MoEN): Engagement motivations, perceived value, satisfaction, and continued engagement intention. Decision support systems 2013; 56: 361-70. https://doi.org/10.1016/j.dss.2013.07.002

[35] Huber GP. A theory of the effects of advanced information technologies on organizational design, intelligence, and decision-making. Academy of Management Review 1990; 15(1): 47-71. https://doi.org/10.2307/258105

[36] Punchoojit L, Hongwarittorrn N. Usability studies on mobile user interface design patterns: a systematic literature review. Advances in Human-Computer Interaction 2017; 2017. https://doi.org/10.1155/2017/6787504

[37] Harrison R, Flood D, Duce D. Usability of mobile applications: literature review and rationale for a new usability model. J Interact Sci 2013; 1: 2013. https://doi.org/10.1186/2194-0827-1-1

[38] Sheth R, Brahmbhatt K. Geo-Tagging of Agricultural Products Using Mobile Application in Remote Areas. Reliability: Theory & Applications 2021; 16(SI 1 (60)): 369-75. Available from: https://www.gnedenko.net/Journal/2021/SI_012021/RTA_SI_1_2021-36_369-375.pdf.

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